

## ARRANGEMENT FOR COOLING A CIRCUIT BOARD OR THE LIKE

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## CROSS-REFERENCE:

This application is a section 371 of PCT/EP2005/010652 filed 4 OCT. 2005.

## FIELD OF THE INVENTION:

The invention relates to an arrangement for cooling a circuit board or the like.

## BACKGROUND:

It is known to cool directly, by means of miniature and subminiature fans, regions of a circuit board at which a great deal of heat is generated. Such regions are usually referred to as "hot spots."

A disadvantage in this context is that the area on which such a fan is installed is no longer available for components, as indicated by DE 195 03 521 A1, AMRHEIN et al.

It is also disadvantageous that the cooling air flow generated by usual miniature fans is poorly suited, because of its shape, for direct cooling close to the surface on circuit boards.

## SUMMARY OF THE INVENTION:

It is therefore an object of the invention to furnish a new arrangement for cooling a circuit board or the like.

According to the invention, this object is achieved by an arrangement including a fan mounted on a carrier frame, and associated with an air-directing element, for cooling a circuit board. In this context, a carrier frame is provided on which a miniature or subminiature fan is mounted, and provided on this carrier frame is an air-directing element which serves to deflect the flow direction of at least a portion of the air transported, during operation, through the air passage aperture. The result is to generate an air flow that is particularly suitable for cooling a circuit board; and it is also possible to arrange components on the circuit board below such an arrangement, and to cool them with the arrangement. Components generating a great deal of heat can, for example, be arranged directly at the fan in the strongest air flow. The latter can be directed either toward the circuit board, or away from it in order to extract hot air from the circuit board.

Another manner according to the present invention of achieving the stated object is a structure in which a support member is spaced above the circuit board and supports a fan whose output air is directed by an air-directing element. A carrier frame of this kind can itself form part of the fan, holds it at a distance from a circuit board that is to be cooled, and also directs the air flow generated by the fan in the desired direction.

Another manner of achieving the stated object is to employ a carrier frame shaped like an offshore oil drilling ring, having a platform configured with a depression for installation of the cooling fan. A carrier frame of this kind can be installed easily and in foolproof fashion, and is mounted in very stable fashion on the circuit board after being installed.

Further details and advantageous refinements of the invention are evident from the exemplifying embodiments, in no way to be understood as a limitation of the invention, that are described below and depicted in the drawings.

#### BRIEF FIGURE DESCRIPTION:

FIG. 1 is a schematic section through an arrangement according to the present invention having a carrier frame, a miniature fan mounted thereon, and an air-directing element for deflecting the air flow generated by the fan;

FIG. 2 is an oblique view from below of the fan of FIG. 1, with a partially sectioned depiction of the electrical connecting elements of the miniature fan;

FIG. 3 is a partially sectioned side view of the arrangement according to Figures 1 and 2, depicted here after it has been installed on a circuit board;

FIG. 4 depicts detail II of FIG. 2;

FIG. 5 is a three-dimensional depiction of a carrier frame and its air-directing member 5, but before installation of the miniature fan and viewed obliquely from above;

FIG. 6 is a three-dimensional depiction analogous to FIG. 5 but viewed from below, i.e. from the circuit-board side;

FIG. 7 is an exploded view of a circuit board, a carrier frame, a fan, and the electrical connection elements of that fan;

FIG. 8 shows a variant of FIG. 3 in which, instead of a latching hook, a round double spring is used which has an annular groove that is latched into a round orifice 70 of circuit board 2;

FIGS. 9 to 23 show different variants of the air-directing bell used in FIGS. 1 to 8; these variants enable even electronic components that are arranged directly below the carrier frame to be cooled with a predetermined portion of the cooling air flow generated by the miniature fan;

FIG. 24 is a greatly enlarged exploded depiction of another exemplifying embodiment of an arrangement according to the present invention, having a carrier frame and a miniature fan that is equipped with a circuit plate for electrical connection thereof and that is mounted, along with the circuit plate, on that carrier frame; and

FIG. 25 is a three-dimensional depiction of the arrangement according to FIG. 24 in a partial section viewed along line XXV-XXV of FIG. 24, the circuit plate being depicted in its installed state but without the fan.

#### DETAILED DESCRIPTION:

Identical reference characters in the Figures designate identical or identically functioning elements. Terms such as "above," "below," "left," and "right" refer to the respective Figure.

FIG. 1 is a schematic longitudinal section through an arrangement 1 according to the present invention. That arrangement has as its principal constituents a fan 3 having a fan wheel 31 whose fan blades are depicted at 32, and having an electric motor 33 to drive fan wheel 31. Arrangement 1 furthermore has a carrier frame 4 which carries fan 3 and on which the latter is mounted. Support elements 41a and latching elements 41b are shaped onto carrier frame 4. By means of latching elements 41b, carrier frame 4 can be mounted on a circuit board 2 by being clipped in. Components 21 that are to be cooled are depicted schematically on circuit board 2. FIG. 8 shows an alternative, preferred manner of mounting onto circuit board 2.

Fan 3 is arranged, with its fan wheel 31, in such a way that on its side C facing away from circuit board 2, it takes in an air flow having a direction substantially perpendicular to circuit board 2 (direction of rotation axis A of fan 3). At least a portion of this air flow is deflected, by an air-directing element 5 that is approximately bell-shaped, in such a way that this air flow proceeds approximately parallel to circuit board 2 and thereby optimally cools components 21.

Arrangement 1 thus performs multiple functions:

By means of latching elements 41b and support elements 41a, or latching feet 80 as shown in FIG. 8, it enables very rapid installation on circuit board 2.

It constitutes a spacing member that holds fan 3 at a desired distance from circuit board 2.

It constitutes an outer casing, namely a so-called venturi conduit, for blades 32 of fan 3, i.e. it completes fan 3 to form an equipment fan of ordinary design.

It shapes the air flow so as to optimize the cooling of components 21 on circuit board 2.

It reduces the area of circuit board 2, since components 21 can also be installed on circuit board 2 below arrangement 1, for example components that generate little heat, or components for which a portion of the air flow is diverted for cooling, as will be explained below with reference to FIGS. 9 to 23.

Ends 44 of support elements 41a serve to support arrangement 1 on circuit board 2. Latching elements 41b have, at their respective ends, a latching hook 43 for engagement behind an opening 22 in circuit board 2. Support elements 41a have a positioning extension 44 for retention at an associated complementary opening 23 of circuit 2. This makes possible simple, reversible installation of arrangement 1 on a circuit board 2. Electrical termination of electric motor 33 can be effected by soldering in a solder bath, together with the soldering of components 21. Electric motor 33 is electrically connected for this purpose, by means of a circuit plate 6, to wire connections 61. This allows the use of standard fans having standardized electrical terminals. Circuit plate 6 rests on a flange or support member 45 (which also carries fan 3) of carrier frame 4. Ends 62 of wire connections 61 are soldered, in the installed state, to conductors on circuit board 2.

As FIG. 5 shows, support member 45 has an inner elevated rim 48 and an outer elevated rim 49 which serve to receive circuit plate 6. The latter has, as depicted in FIG. 7, a radially extending connecting part 64, and this part is guided radially outward through a cutout 49a (FIG. 5) of outer rim 49 and joined to vertically